The opinion in support of the decision being entered today was _not_ written for publication and is _not_ binding precedent of the Board.

Paper No. 23

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte HIROAKI YAMADA

Appeal No. 2000-1608
Application 08/953,998[1]

HEARD: January 17, 2002

Before KRASS, BARRETT, and BARRY, _Administrative Patent Judges_.

BARRETT, _Administrative Patent Judge_.

DECISION ON APPEAL

This is a decision on appeal under 35 U.S.C. § 134 from the final rejection of claims 1-6.

We reverse.

[1] Application for patent filed October 20, 1997, entitled "Simulation Method of Sputtering," which claims the foreign filing priority benefit under 35 U.S.C. § 119 of Japanese Application 277752, filed October 21, 1996.

BACKGROUND

The disclosed invention relates to a method of simulating a sputtering process. In Appellant's former simulation method, described in connection with Fig. 1, the polar angular distribution of extracted sputtered particles from a target (i.e., atoms ejected from the surface further than a cut-off distance) is calculated using the molecular dynamics (MD) method for N particles, where N is limited to 100-200 because of calculation time (step P1). Then the angular distribution of ejection is read out (step P2) and used to calculate a track of the sputtered particle by means of the Monte Carlo (MC) method, and the sputtered particles which arrive at a specific region on a wafer are extracted (step S5). The shape of the region where the particles actually arrive is then calculated (step S6).

The problem with this former method is that the sampling errors in directional components of the possible tracks of the sputtered particles depend on the number of ejection angle data N. Because N is as small as 100-200, the random number error can be large. It is advantageous to make the number of ejection angle data N as great as possible in order to minimize the sampling error, but the number N needs to be kept small because of the limitation in MD calculation time.

The invention creates a larger number of ejection angle data from the calculated ejection angle data N. The calculated ejection angle data N is used to calculate a continuous vertical distribution function F(θ) shown in Fig. 3A. Then, sets of two-dimensional uniform random numbers are used to simulate an ejection. The first random number designates a value of the vertical angle θ and the second random number represents a value of the function F(θ); these random numbers are plotted as the point A in Fig. 3A. The sets that fall inside the shaded area are accepted as events of ejection that are likely to occur at angles of θ indicated by the first random numbers. The horizontal angle φ is assumed to be a uniform random number. Tracks of sputtered particles are calculated using the values of the vertical angles and horizontal angles determined using the uniform random numbers. Using the distribution function F(θ) requires much less calculation than the MD method.

Claim 1 is reproduced below.

> 1. A method of simulating a sputtering process, wherein an ejected direction of a particle from a target is designated in polar coordinates (θ,φ), a vertical angle θ denoting an angle of said ejected direction with respect to a z-axis that is defined at an incident point of a bombarding particle on a surface plane of said target and is directed perpendicularly to said surface plane of said target and a horizontal angle φ denoting an angle of an intersection line with respect to an x-axis, an xy-plane being said surface plane of the target, x-axis being an arbitrarily defined axis on said xy-plane, and said intersection line being an intersection of a plane that includes both said z-axis and said ejected direction with said xy-plane, comprising:
>
> a first step of calculating a direction-dependent distribution of ejected particles from said target;

a second step of dividing a range of said vertical angle θ into sections of an equal interval, counting a number of the ejected particles for every section of said vertical angle θ, and calculating a vertical distribution function by interpolating the counted numbers of the ejected particles as a function of said vertical angle θ,

a third step of determining values of said vertical angle θ likely to emerge in a random process of a particle ejection from said target using said vertical distribution function as a criterion to judge whether the particle ejection at said vertical angle θ is to be accepted as likely to occur or to be rejected as unlikely to occur,

a fourth step of determining values of said horizontal angle ϕ likely to emerge in a random process of a particle ejection from said target, and

a fifth step of calculating tracks of sputtered particles in a sputtering arrangement using the values of said vertical angles and said horizontal angles determined by the third step and the fourth step in accordance with the Monte Carlo method.

The Examiner relies on the following prior art:[2]

Yamada et al. (Yamada), A Sputter Equipment Simulation System Including Molecular Dynamical Target Atom Scattering Model, IEEE Proc. of Int'l Elec. Devices Mtg., Washington, DC, Dec. 10-13, 1995, pp. 93-96 (numbered as 4.5.1-4.5.4 in the reprint copy).

Claims 1-6 stand rejected under 35 U.S.C. § 101 as being directed to nonstatutory subject matter as an algorithm.

Claims 1-6 stand rejected under 35 U.S.C. § 112, second paragraph, as indefinite for failing to particularly point out

[2] In the examiner's answer, the Examiner cites supplemental prior art in response to Appellant's arguments. This prior art is not part of the art rejection. We find it unnecessary to rely on this supplemental prior art in any way; thus, it will not be listed or discussed.

and distinctly claim the subject matter which Appellant regards as his invention.

Claims 1-6 stand rejected under 35 U.S.C. § 102(a) as being anticipated by Yamada.

We refer to the final rejection (Paper No. 8) (pages referred to as "FR__") and the examiner's answer (Paper No. 17) (pages referred to as "EA__") for a statement of the examiner's position and to the brief (Paper No. 14) (pages referred to as "Br__") and the reply brief (Paper No. 18) (pages referred to as "RBr__") for a statement of Appellant's arguments thereagainst.

OPINION

Note

In Fig. 2 of Appellant's drawings, step S42 within step S4 should read "Determine Horizontal angle."

Grouping of claims

The Examiner states that the claims stand or fall together because there is only one independent claim and because Appellant has argued throughout the prosecution as though the claims stand or fall together (EA3).

Appellant notes that claims 2-6 were argued separately in the brief in connection with the § 103(a) rejection (RBr2).

Regardless of how claims are argued during prosecution, (and we will not investigate this), Appellant has the right to argue the claims separately on appeal. Appellant stated that the claims in the group do not stand or fall together (Br4) and argued the claims separately in the anticipation rejection (Br9-10). The Examiner should have addressed the dependent claims in connection with the anticipation rejection. However, since we reverse the rejection of claim 1, the rejection of the dependent claims is also reversed. Thus, it is not necessary to remand for further action by the Examiner.

35 U.S.C. § 101

The Examiner's sole reasoning is that the claims are directed to an algorithm, specifically, a sputtering simulation algorithm and that no application of the invention is claimed (EA4). The Examiner states that the substitute specification discloses the need and use for the simulation results and that incorporation of the use may overcome the § 101 rejection (EA6).

Appellant argues that any step-by-step process involves an "algorithm" in the broad sense of the term (Br5). It is argued that the § 101 proscription, to the sense it still exists, is narrowly limited to mathematical algorithms in the abstract (Br5). Appellant argues that the present claims recite a process having a practical application and producing a useful, concrete, and tangible result and is statutory subject matter (Br5).

We interpret the Examiner's reference to "algorithm" to refer to "mathematical algorithms." The exception to § 101 applies only to mathematical algorithms since any process is an "algorithm" in the sense that it is a step-by-step procedure to arrive at a given result. See In re Walter, 618 F.2d 758, 764 n.4, 205 USPQ 397, 405 n.4 (CCPA 1980). "[T]he judicially-defined proscription against patenting of a 'mathematical algorithm,' to the extent such a proscription still exists, is narrowly limited to mathematical algorithms in the abstract." AT&T v. Excel Communications, Inc., 172 F.3d 1352, 1356, 50 USPQ2d 1447, 1450 (Fed. Cir. 1999) (citing State St. Bank & Trust Co. v. Signature Fin. Group, Inc., 149 F.3d 1368, 1374-75, 47 USPQ2d 1596, 1602 (Fed. Cir. 1998)). The key to statutory subject matter is whether the claimed subject matter is applied in a "useful way" or directed to a "practical application," which the Federal Circuit has said requires "a useful, concrete and tangible result." State St., 149 F.3d at 1375, 47 USPQ2d at 1602. It is not required that there be a "physical transformation" or conversion of subject matter from one state into another for there to be statutory subject matter. AT&T, 172 F.3d at 1358-59, 50 USPQ2d at 1452-53.

Although the steps of claim 1 involve mathematical calculations, the subject matter of claim 1 is not directed to a mathematical algorithm per se (i.e., a mathematical in the abstract) because it is directed to calculation of real world, physical phenomena: "calculating tracks of sputtered particles in a sputtering arrangement" (fifth step of claim 1). This, we conclude, is a "practical application" because it produces a "useful, concrete and tangible result," the tracks of the sputtered particles, not a mere number. That the calculated tracks of the sputtered particles are not further applied to calculate the shape of the area where the particles are deposited does not make the method any less physical or useful. We conclude that claims 1-6 are directed to statutory subject matter as a process under 35 U.S.C. § 101. The rejection of claims 1-6 under § 101 is reversed.

<u>35 U.S.C. § 112, second paragraph</u>

The Examiner stated that "ejected direction of a particle" in claim 1 is grammatically incorrect (Paper No. 4, p. 4) and should be replaced with "direction of an ejected particle" (FR3).

Appellant argues that the language is specific and definite and easier to refer to than to designate "direction of ejected particle," "direction of incident ion," etc. (Br5-6).

The Examiner states that "ejected direction of a particle" in claim 1 is grammatically incorrect because "ejected" is a verb, not a noun, and the "direction" is not being ejected (EA6). The Examiner finds the phrase ambiguous (EA6).

Appellant replies that "ejected" is an adjective modifying the noun "direction" (RBr2). It is further argued that although the Examiner claims the phrase is ambiguous, the Examiner appears to have a complete understanding of what the term means (RBr2).

While we do not profess to be grammar experts, we do know that the word "ejected" is a past participle used as an adjectival (a word or group of words which functions as an adjective) to modify the noun phrase "direction of the particle," and it is not being used as a verb as stated by the Examiner. It seems to us that noun phrase "direction of a particle" is merely another way to say "particle direction" and that the "ejected direction of a particle" is just another way to say "ejected particle direction" and is not wrong or indefinite. Although the Examiner states that the phrase "ejected direction of a particle" is ambiguous, he does not explain what two or more interpretations are possible. We conclude that claim 1 satisfies the definiteness requirements of 35 U.S.C. § 112, second paragraph. The rejection of claims 1-6 under § 112, second paragraph, is reversed.

35 U.S.C. § 102(a)

The simplest and most direct way to show anticipation is to explain where each claim limitation is found, either expressly or by principles of inherency, in the reference. This correlation has not been attempted by the Examiner even though claim 1 is not that complicated. Appellant argues that the Examiner has used language and made findings that are more appropriate to an obviousness rejection (Br7). In response, the Examiner has spent considerable time and effort discussing the arguments in Appellant's brief. General discussions of Monte Carlo techniques and what was known in the art are of no help to us in addressing the specifics of claim 1. Therefore, we make our own findings regarding the anticipation rejection over Yamada.

We find that Yamada is essentially directed to the admitted prior art of Appellant's Fig. 1, wherein ejection angle distribution values calculated using MD techniques are used to calculate atom trajectories using the MC method. Yamada does not teach the second, third, fourth, and fifth steps of claim 1.

The characteristic feature of Appellant's invention is calculating (in a particular way) a continuous vertical distribution function from a calculated direction-dependent distribution of ejected particles (second step). Then the distribution function is used to determine a value of the vertical angle θ likely to emerge in a random process of a particle ejection (third step) and a value of a horizontal angle ϕ likely to emerge in a random process of a particle ejection is determined (fourth step). Last is the step of calculating tracks of sputtered particles using the values determined from the third and fourth steps (fifth step).

While Yamada discloses a continuous vertical distribution function in Fig. 5, there is no description that it was obtained using the method in the second step of claim 1 ("dividing a range ..."). There is no description of using the vertical distribution function to determine values of the vertical angle θ as recited in the third step. It is clear that the ejection angles used in the MC method in Yamada are calculated using MD techniques (p. 4.5.2), which the Examiner appears to recognize (EA11), not from the vertical distribution function using uniform random numbers. Further, there is no description of determining the value of a horizontal angle ϕ likely to emerge in a random process of a particle ejection as recited in the fourth step. Again, it is clear that the ejection angles used in the MC method are calculated using MD techniques and are not based on the assumption that the values of the horizontal angle ϕ emerge in an equal probability which can be designated by uniform random numbers. Because Yamada does not disclose the second, third, or fourth steps, it manifestly does not disclose the fifth step which relies on the third and fourth steps. Accordingly, the Examiner's finding of anticipation is clearly erroneous. The rejection of claims 1-6 under § 102(a) is reversed.

CONCLUSION

The rejections of claims 1-6 are reversed.

REVERSED

ERROL A. KRASS Administrative Patent Judge	)	
LEE E. BARRETT Administrative Patent Judge	)	BOARD OF PATENT APPEALS AND INTERFERENCES
LANCE LEONARD BARRY Administrative Patent Judge	)	

SUGHRUE, MION, ZINN, MacPEAK & SEAS
2100 Pennsylvania Avenue, N.W.
Washington, DC 20037-3202